National Aeronautics and Space Administration

# Evolving our Evaluation of Luminous Environments

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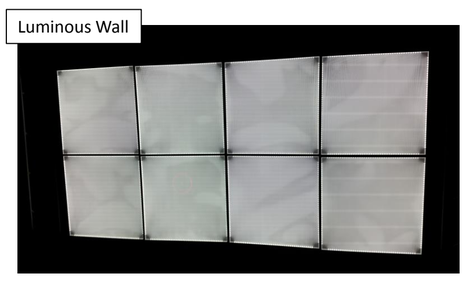
**HAT:** 12.1, 6.3, 6.4, 3.4, 7.4 **TA:** 6.4 Human Health & Performance, 7.4 Habitat Systems **TRL:** start 1 / current 3

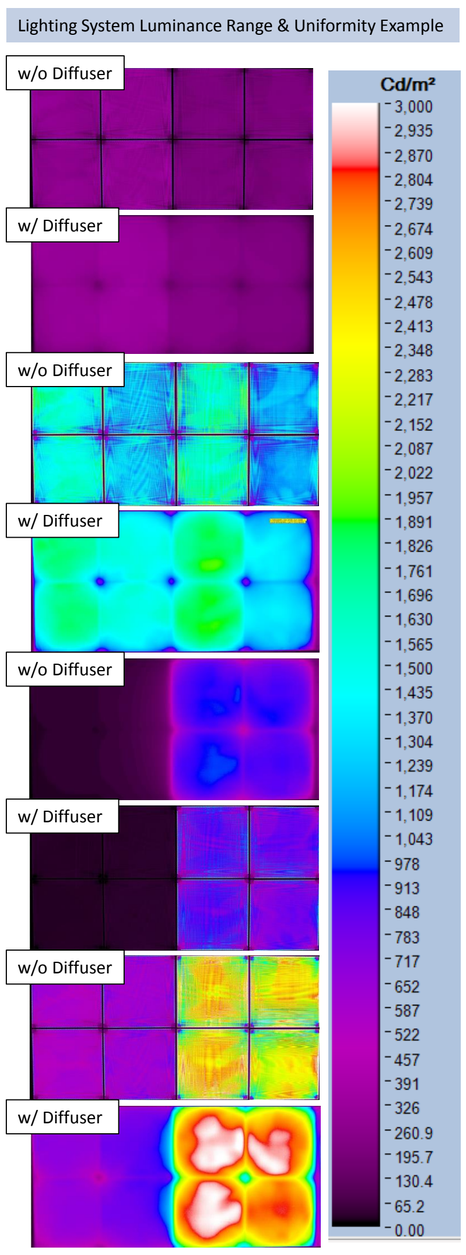
## OVERVIEW

The advance in solid state light emitting technologies and optics for lighting and visual communication necessitates the evaluation of how NASA envisions spacecraft lighting architectures and how NASA uses industry standards for the design and evaluation of lighting systems. Current NASA lighting standards and requirements for existing architectures focus on the separate ability of a lighting system to throw light against a surface or the ability of a display system to provide the appropriate visual contrast. This project investigated large luminous surface lamps as an alternative or supplement to overhead lighting. The efficiency of the technology was evaluated for uniformity and power consumption.

## INNOVATION

The team built a 4x8 foot "luminous wall" out of thin LED edge lit panels at the Lighting Environment Test Facility at JSC. The system had power monitors, and was designed to have a fine increment in brightness from zero to maximum intensity. We evaluated lighting uniformity, perception of change in luminance, horizontal illuminance from a vertical surface, efficiency, and novelty.




## OUTCOME

### Brightness Ratios:

The luminous surface panels provide an environment, free of glare and typical non-uniformities created by standard lamp systems. Usage of a diffuser panel created a higher resolution of uniformity while the absence of the diffuser panel created larger areas of the same average luminance.

### Illumination:

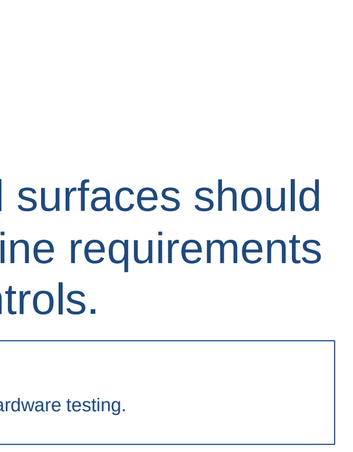
The lighting system was able to provide required task light levels with horizontal illuminance (light striking typical location of hands) adequate for general tasks (138 lux) at 25% "ON" and illumination sufficient for most reading tasks at 45% "ON" (428 lux).

### Power Usage:

Power usage data showed promising results as average power required for the same self luminous brightness value was lower and produced a more uniform intensity than what could be provided by a standard lamp projecting onto a surface. A 2'x2' lamp section at a max light output of 30 watts, was capable of producing a surface luminance of 3000 cd/m^2, and illuminance values at 1 meter of 1300 lux. This intensity range indicates a potential solution to counteract reflected glare from sunlight entering the cabin.

### Comparison With Conventional Lamp Systems:

The simulation looked at energy required for a conventional lamp to produce the same surface luminance due to reflected light verses a surface that was self luminous. To produce a uniform luminance of 206 cd/m^2, a fluorescent lamp, mounted at approximately 8ft, used 50 watts, and luminous wall used 3.2 watts. Light panel surface area of uniform luminance was at least 2x the area of uniform luminance as compared to the lamp.




## INFUSION SPACE / EARTH

Inclusion of the luminance metric enables the usage of surface panel lighting technologies which address a range of ambient lighting conditions while potentially reducing power usage.

## FUTURE WORK

Integrators of self luminous architectural surfaces should perform human-in-the loop testing to refine requirements for system implementation and user controls.

## ACKNOWLEDGEMENTS

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